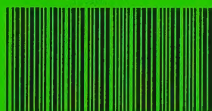


HIGH AND LOW PASS FILTERS

## Equipment Manual

MP MASTER

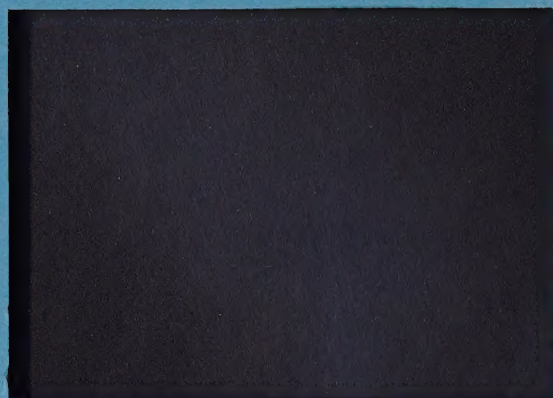


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**MULLARD EQUIPMENT LIMITED**

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HIGH AND LOW PASS FILTERS

Equipment Manual

Technical Publications Department

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## HIGH AND LOW PASS FILTERS

Types - GFF001/01 and GFF001/02

### AMENDMENT

#### Front-Panel Connections (Fig. 1a)

The two terminals to the left of the cut-off frequency switch are the Input terminals. The upper two to the right of the switch are the Output terminals and the terminal immediately below them is the Earth terminal.

The input may be monitored by means of high impedance headphones connected to the jack socket on the left of the front panel, the output at the right-hand jack socket.



## VARIABLE CUT-OFF HIGH AND LOW PASS FILTERS

### TYPES GFF 001/02 and GFF 001/01

#### Introduction

These variable cut-off filters, have many uses in laboratory and communication work for frequency limiting or, when used as a pair, for sampling. The input and output impedance is 600ohms.

A great reduction in space has been achieved by the careful design of these filters and by the use of Ferroxcube pot cores. Previous equipment of this nature has occupied nearly twice as much panel space for each filter as is required by the whole of this unit.

The cut-off frequencies are so arranged that each is 1.5x the preceding frequency, ranging from 400c/s to 15,400c/s on the low pass panel, and from 440c/s to 16,800c/s on the high pass panel.

The filters are arranged for mounting in a standard 19 in. rack, but will stand on a bench if required. Screw terminals, jack sockets and soldering tags (inside the filter unit) provide a variety of input and output connections.

A front view of the low pass filter is shown in fig. 1(a). The high pass filter is similar. Fig. 1(b) and 2 illustrate the filters with the dust covers removed, showing the method of construction.

#### TECHNICAL SUMMARY

##### 1. High-Pass filter (Type GFF 001/2)

|                          |                                                                                                                                                    |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Cut-off frequencies (fc) | 440, 660, 990, 1480, 2222, 3333, 5000, 7500, 11250, 16800c/s<br>selected by a switch.                                                              |
| Impedances               | Input and output 600ohms, balanced or unbalanced.                                                                                                  |
| Stopband attenuation     | Below 0.8fc - greater than 45dB on lowest range; greater than 50dB on all other ranges.                                                            |
| Passband attenuation     | Less than 7dB on all ranges from 1.1fc to 20 or 25kc/s depending on cut-off frequency (fc). Limits for the individual ranges are shown in Table 1. |



TABLE 1

| fc       | Loss at 0.4fc | 0.74fc   | 1.0fc    | 1.1fc   | 1.5fc   |
|----------|---------------|----------|----------|---------|---------|
| 440c/s   | 45dB min      | 55dB min | 13dB max | 7dB max | 5dB max |
| 660c/s   | 65 " "        | 55 " "   | 11 " "   | 5 " "   | 5 " "   |
| 990c/s   | 65 " "        | 55 " "   | 11 " "   | 5 " "   | 5 " "   |
| 1480c/s  | 65 " "        | 50 " "   | 10 " "   | 5 " "   | 5 " "   |
| 2222c/s  | 65 " "        | 50 " "   | 8 " "    | 4 " "   | 4 " "   |
| 3333c/s  | 65 " "        | 50 " "   | 8 " "    | 4 " "   | 4 " "   |
| 5000c/s  | 65 " "        | 50 " "   | 8 " "    | 4 " "   | 4 " "   |
| 7500c/s  | 60 " "        | 50 " "   | 7 " "    | 4 " "   | 4 " "   |
| 11250c/s | 60 " "        | 50 " "   | 6 " "    | 4 " "   | 5 " "   |
| 16800c/s | 55 " "        | 50 " "   | 6 " "    | 5 " "   | 5 " "   |

2. Low-Pass filter (Type GFF 001/01)

Cut-off frequencies (fc) 400, 600, 900, 1350, 2025, 3040, 4560, 6830, 10250, 15400c/s selected by a switch.

Impedances Input and output 600ohms, balanced or unbalanced.

Stopband attenuation Above 1.25fc - greater than 50dB.

Passband attenuation Less than 5dB from 50c/s to 0.9fc on all ranges. Limits for the individual ranges are shown in Table 2.

TABLE 2

| fc       | Loss at 0.7fc | 0.9fc   | 1.0fc      | 1.35fc   | 2.5fc    |
|----------|---------------|---------|------------|----------|----------|
| 400c/s   | 4dB max       | 4dB max | 11.5dB max | 50dB min | 70dB min |
| 600c/s   | 4 " "         | 4 " "   | 11 " "     | 50 " "   | 70 " "   |
| 900c/s   | 4 " "         | 4 " "   | 10 " "     | 50 " "   | 70 " "   |
| 1350c/s  | 4 " "         | 4 " "   | 10 " "     | 50 " "   | 70 " "   |
| 2025c/s  | 4 " "         | 4 " "   | 9 " "      | 50 " "   | 70 " "   |
| 3040c/s  | 4 " "         | 4 " "   | 9 " "      | 50 " "   | 70 " "   |
| 4560c/s  | 3 " "         | 3 " "   | 8 " "      | 50 " "   | 70 " "   |
| 6830c/s  | 3 " "         | 3 " "   | 8 " "      | 50 " "   | 70 " "   |
| 10250c/s | 3.5 " "       | 3.5 " " | 8 " "      | 50 " "   | 70 " "   |
| 15400c/s | 3.5 " "       | 5 " "   | 13 " "     | 50 " "   | 50 " "   |



MECHANICAL DETAILS

|                               |                                                                                                         |            |              |
|-------------------------------|---------------------------------------------------------------------------------------------------------|------------|--------------|
| Mounting                      | Rack mounting (19 x 3½in. panel)<br>Fitted steel dust cover.                                            |            |              |
| Input and Output terminations | Insulated terminals, jack, type<br>300 B6/N or internal terminal blocks<br>for inclusion in bay wiring. |            |              |
| Finish                        | Grey cellulose enamel.                                                                                  |            |              |
| Dimensions                    | Panel:                                                                                                  | 19 x 3½in. | 48.2 x 8.8cm |
|                               | Depth:                                                                                                  | 5in.       | 12.7cm       |
| Weight                        |                                                                                                         |            |              |
| Low Pass                      | 11½lb. (5.2kg)                                                                                          |            |              |
| High Pass                     | 11¼lb. (5.1kg)                                                                                          |            |              |

OPERATION

The cut-off frequencies of the individual sections are 1.5x the preceding frequency. This value was chosen to be a suitable compromise between the number of sections required to cover the frequency range and the decrease in attenuation due to the adjacent sections being too widely spaced.

In order that the filters might be used in tandem as Band Pass filters, the cut-off frequencies have been staggered, the lowest on the low pass panel being 400c/s and that on the high pass panel being 440c/s. This arrangement allows selection of non-overlapping frequencies with a ratio of 1.3:1 between the upper and lower frequencies transmitted. At the same time, the spacing ratio of the mid-band frequencies of the pass band will be the same as the ratio of the cut-off frequencies of the various sections i.e. 1.5:1.

In addition, by switching the high and low pass filters 2 steps higher than the fundamental frequency, it is possible to obtain (to a first approximation) octave samples; for example, if the fundamental frequency is 500c/s, the high pass filter would be set to 440c/s and the low pass filter to 600c/s, giving a mid-band frequency of 520c/s; by switching 2 steps higher, i.e. high pass filter to 900c/s, low pass filter to 1350c/s, the mid-band of the sample would be 1170c/s and thus approximate octave sampling could be obtained.

The input and output should be connected to the appropriate terminals on the front panel or to the soldering points in the filter and a connection made from the earth terminal to earth. Since the input and output impedances are similar, the input and output may be interchanged if so desired. The input and output may be monitored by



by connecting high impedance headphones across the lines by means of the jack sockets on the front panel.

### Input Levels

The filters are primarily intended for use at low levels, i.e. of the order of a few milliwatts or inputs up to about 1 volt. However, the filters may be used without damage to the components at inputs of up to 1 watt.

Inputs greater than a few milliwatts will produce harmonic distortion, the amount of which will depend to a great extent on the levels and frequencies applied. The particular application will determine the amount of distortion which can be tolerated and thus the permissible input level. The amount of harmonic distortion to be expected is as follows:-

#### High Pass Filter

For inputs up to 2.5V at a frequency in the stop band, whose third harmonic lies in the pass band, the harmonic output will be, in the worst case, less than 35mV, i.e. discrimination against the third harmonic will be greater than 37dB.

#### Low Pass Filter

For inputs up to 8V at a frequency in the pass band, whose third harmonic lies in the stop band, the harmonic output will be, in the worst case, less than 35mV, i.e. discrimination against the third harmonic will be greater than 47dB.

### CIRCUIT DESCRIPTION

#### Low Pass Filter

The low pass filter consists of three prototype  $\pi$  sections and one shunt derived section connected in tandem.

Eight inductors are used in two groups of four, each group covering five filters.

A pair of wide-band transformers are used to ensure correct matching of the filter into the standard 600ohm line. These transformers limit the lower pass band frequencies of the filter.

#### High Pass Filter

The high pass filter consists of three full prototype sections and one series derived section connected in tandem.



The filter is divided into two groups of five filters. Each group uses three inductors and one pair of transformers.

Separate transformers are necessary for each group as the secondary windings are used with associated capacitors to form half prototype filter sections.

In both filters all inductors are wound on high-efficiency Ferroxcube pot cores. High-grade polystyrene capacitors mounted on printed circuit boards are used throughout.

#### MAINTENANCE

The only moving parts in the filters are the 10-way switches, and these are the only parts requiring maintenance.



LOW PASS FILTERPARTS LIST

| <u>Circuit<br/>Ref.</u> | <u>Value</u> | <u>Tol.<br/>(<math>\pm</math> %)</u> | <u>Rating</u> | <u>Description</u>  | <u>Code No.</u> |
|-------------------------|--------------|--------------------------------------|---------------|---------------------|-----------------|
| C1                      | 2928pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C2                      | 6585pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C3                      | 14827pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C4                      | 33362pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C5                      | 75073pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AF           |
| C6                      | 386pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C7                      | 867pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C8                      | 1953pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C9                      | 4394pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C10                     | 9887pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C11                     | 4482pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C12                     | 10080pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C13                     | 22698pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C14                     | 51073pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C15                     | 57460pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C15a                    | 57460pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C16                     | 459pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C17                     | 1328pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C18                     | 2270pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C19                     | 6734pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C20                     | 15154pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C21                     | 4482pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C22                     | 10080pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C23                     | 22698pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C24                     | 51073pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C25                     | 57460pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C25a                    | 57460pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C26                     | 459pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C27                     | 1328pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C28                     | 2270pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C29                     | 6734pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C30                     | 15154pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C31                     | 5856pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C32                     | 13182pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C33                     | 29654pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C34                     | 66725pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C35                     | 75073pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AF           |
| C35a                    | 75073pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AF           |
| C36                     | 771pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C37                     | 1734pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C38                     | 3905pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C39                     | 8788pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C40                     | 19774pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C41                     | 2928pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C42                     | 6585pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C43                     | 14827pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |



| <u>Circuit</u><br><u>Ref.</u> | <u>Value</u> | <u>Tol.</u><br><u>(± %)</u> | <u>Rating</u> | <u>Description</u>  | <u>Code No.</u> |
|-------------------------------|--------------|-----------------------------|---------------|---------------------|-----------------|
| C44                           | 33362pF      | 1                           | 125V          | Polystyrene Moulded | PF-AE           |
| C45                           | 75073pF      | 1                           | 125V          | Polystyrene Moulded | PF-AF           |
| C46                           | 386pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C47                           | 867pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C48                           | 1953pF       | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C49                           | 4393pF       | 1                           | 125V          | Polystyrene Moulded | PF-AB           |
| C50                           | 9887pF       | 1                           | 125V          | Polystyrene Moulded | PF-AD           |
| C51                           | 50782pF      | 1                           | 125V          | Polystyrene Moulded | PF-AE           |
| C52                           | 22567pF      | 1                           | 125V          | Polystyrene Moulded | PF-AT           |
| C53                           | 10029pF      | 1                           | 125V          | Polystyrene Moulded | PF-AE           |
| C54                           | 4454pF       | 1                           | 125V          | Polystyrene Moulded | PF-AB           |
| C55                           | 1980pF       | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C56                           | 6688pF       | 1                           | 125V          | Polystyrene Moulded | PF-AD           |
| C57                           | 2972pF       | 1                           | 125V          | Polystyrene Moulded | PF-AB           |
| C58                           | 1320pF       | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C59                           | 587pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C60                           | 260pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |

## NOTE:

All capacitors are G.E.C. The code number consists of the letters PF followed by the capacitance value (in pF) followed by the second group of letters shown under the code no. heading. Thus the code no. of C1 is PF2928AB.

|     |                     |           |
|-----|---------------------|-----------|
| L1  | Inductor            | MA 021 30 |
| L2  | Inductor            | MA 021 32 |
| L3  | Inductor            | MA 021 31 |
| L4  | Inductor            | MA 021 33 |
| L5  | Inductor            | MA 021 30 |
| L6  | Inductor            | MA 021 32 |
| L7  | Inductor            | MA 021 30 |
| L8  | Inductor            | MA 021 32 |
| T1  | Transformer         | MA 021 34 |
| T2  | Transformer         | MA 021 34 |
| SA  | Switch Rotary       | MA 841 69 |
| JK1 | Jack P.O.           | MR 084 04 |
| JK2 | Jack P.O.           | MR 084 04 |
| TP1 | Terminal (Modified) | MA 146 98 |
| TP2 | Terminal (Modified) | MA 146 98 |



| <u>Circuit</u><br><u>Ref.</u>           | <u>Value</u> | <u>Tol.</u><br><u>(<math>\pm</math> %)</u> | <u>Rating</u> | <u>Description</u>  | <u>Code No.</u> |
|-----------------------------------------|--------------|--------------------------------------------|---------------|---------------------|-----------------|
| TP3                                     |              |                                            |               | Terminal (Modified) | MA 146 98       |
| TP4                                     |              |                                            |               | Terminal (Modified) | MA 146 98       |
| TP5                                     |              |                                            |               | Terminal (Modified) | MA 146 98       |
| TB1                                     |              |                                            |               | Terminal Block Assy | MA 769 41       |
| TB2                                     |              |                                            |               | Terminal Block Assy | MA 769 41       |
| Printed Circuit Board (Less capacitors) |              |                                            | PW 270 A      |                     | MA 759 36       |
| Printed Circuit Board (Less capacitors) |              |                                            | PW 271 B      |                     | MA 759 37       |



HIGH PASS FILTERPARTS LIST

| <u>Circuit<br/>Ref.</u> | <u>Value</u> | <u>Tol.<br/>(<math>\pm</math> %)</u> | <u>Rating</u> | <u>Description</u>  | <u>Code No.</u> |
|-------------------------|--------------|--------------------------------------|---------------|---------------------|-----------------|
| C1                      | 38351pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C2                      | 17043pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C3                      | 7576pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C4                      | 3367pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C5                      | 1496pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C6                      | 49383pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C7                      | 21945pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C8                      | 9755pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C9                      | 4335pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C10                     | 1926pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C11                     | 61050pF      | 1                                    | 350V          | Polystyrene Moulded | PF-BF           |
| C12                     | 61060pF      | 1                                    | 350V          | Polystyrene Moulded | PF-BF           |
| C13                     | 54261pF      | 1                                    | 350V          | Polystyrene Moulded | PF-BF           |
| C14                     | 24118pF      | 1                                    | 350V          | Polystyrene Moulded | PF-BF           |
| C15                     | 10719pF      | 1                                    | 350V          | Polystyrene Moulded | PF-BE           |
| C16                     | 4763pF       | 1                                    | 350V          | Polystyrene Moulded | PF-BD           |
| C17                     | 49383pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C18                     | 21945pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C19                     | 9755pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C20                     | 4335pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C21                     | 1926pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C22                     | 38351pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C23                     | 17043pF      | 1                                    | 125V          | Polystyrene Moulded | PF-AE           |
| C24                     | 7576pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C25                     | 3367pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C26                     | 1496pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C27                     | 5053pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C28                     | 1704pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C29                     | 998pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C30                     | 444pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C31                     | 197pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C32                     | 6506pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C33                     | 2891pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C34                     | 1285pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C35                     | 571pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C36                     | 254pF        | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C37                     | 16087pF      | 1                                    | 350V          | Polystyrene Moulded | PF-BE           |
| C38                     | 7149pF       | 1                                    | 350V          | Polystyrene Moulded | PF-BD           |
| C39                     | 3178pF       | 1                                    | 350V          | Polystyrene Moulded | PF-BD           |
| C40                     | 1412pF       | 2                                    | 350V          | Polystyrene Moulded | PF-BD           |
| C41                     | 628pF        | 2                                    | 350V          | Polystyrene Moulded | PF-CB           |
| C42                     | 6506pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AD           |
| C43                     | 2891pF       | 1                                    | 125V          | Polystyrene Moulded | PF-AB           |
| C44                     | 1285pF       | 2                                    | 125V          | Polystyrene Moulded | PF-AB           |



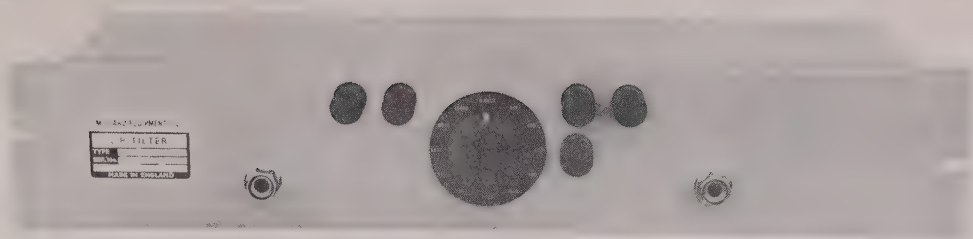
| <u>Circuit</u><br><u>Ref.</u> | <u>Value</u> | <u>Tol.</u><br><u>(± %)</u> | <u>Rating</u> | <u>Description</u>  | <u>Code No.</u> |
|-------------------------------|--------------|-----------------------------|---------------|---------------------|-----------------|
| C45                           | 571pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C46                           | 254pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C47                           | 5053pF       | 1                           | 125V          | Polystyrene Moulded | PF-AB           |
| C48                           | 1704pF       | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C49                           | 998pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C50                           | 444pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |
| C51                           | 197pF        | 2                           | 125V          | Polystyrene Moulded | PF-AB           |

## NOTE:

All capacitors are G.E.C. The code number consists of the letters PF followed by the capacitance value (in pF) followed by the second group of letters shown under the code no. heading. Thus the code no. of C1 is PF38351AE.

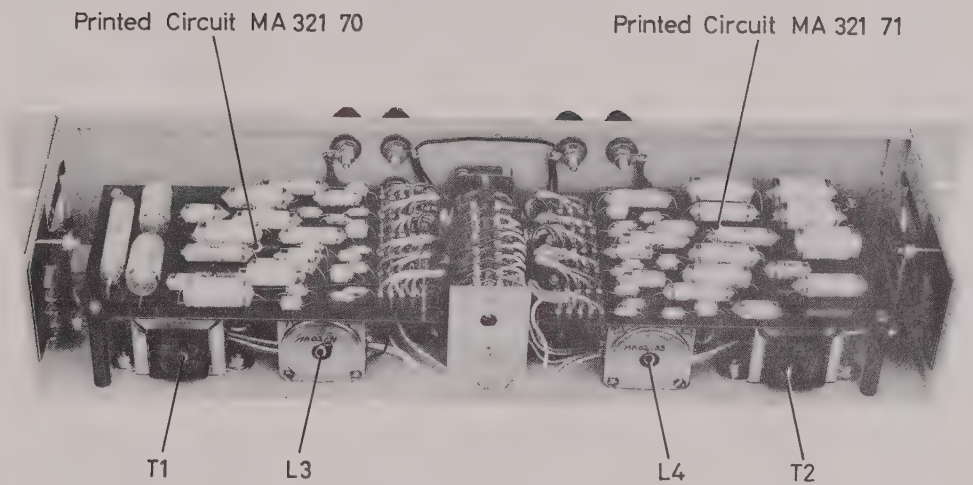
|                                         |                     |           |
|-----------------------------------------|---------------------|-----------|
| L1                                      | Inductor            | MA 021 38 |
| L2                                      | Inductor            | MA 021 39 |
| L3                                      | Inductor            | MA 021 40 |
| L4                                      | Inductor            | MA 021 41 |
| L5                                      | Inductor            | MA 021 38 |
| L6                                      | Inductor            | MA 021 39 |
| T1                                      | Transformer         | MA 021 42 |
| T2                                      | Transformer         | MA 021 43 |
| T3                                      | Transformer         | MA 021 42 |
| T4                                      | Transformer         | MA 021 43 |
| SA                                      | Switch Rotary       | MA 841 70 |
| JK1                                     | Jack P.O.           | MR 084 04 |
| JK2                                     | Jack P.O.           | MR 084 04 |
| TP1                                     | Terminal (Modified) | MA 146 98 |
| TP2                                     | Terminal (Modified) | MA 146 98 |
| TP3                                     | Terminal (Modified) | MA 146 98 |
| TP4                                     | Terminal (Modified) | MA 146 98 |
| TP5                                     | Terminal (Modified) | MA 146 98 |
| TB1                                     | Terminal Block Assy | MA 769 41 |
| TB2                                     | Terminal Block Assy | MA 769 41 |
| Printed Circuit Board (Less capacitors) | PW 272 A            | MA 759 39 |
| Printed Circuit Board (Less capacitors) | PW 273 A            | MA 759 38 |





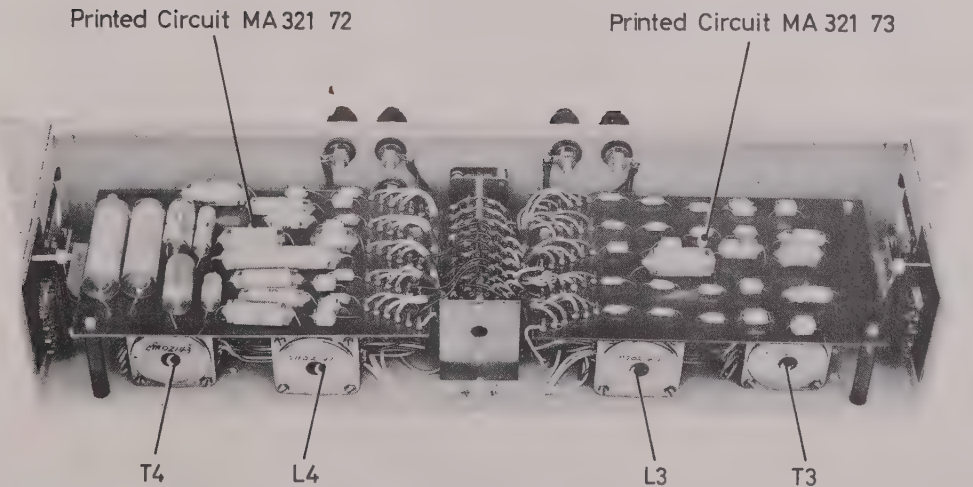
L.P. Filter GFF001/01 ( Front view )

Fig.1(a)



L.P. Filter ( Rear view with cover removed )

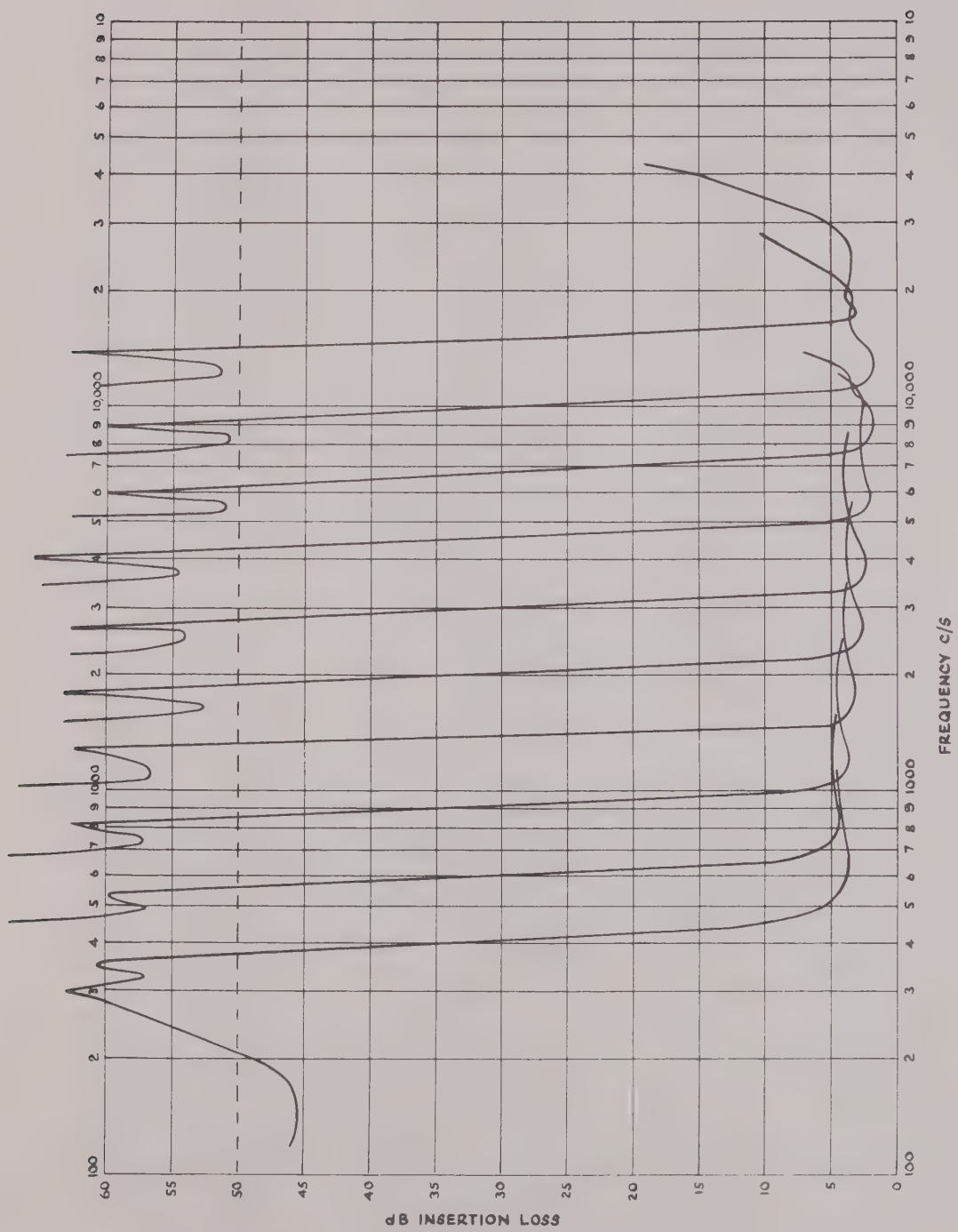
Fig.1(b)



H.P. Filter ( Rear view with cover removed )

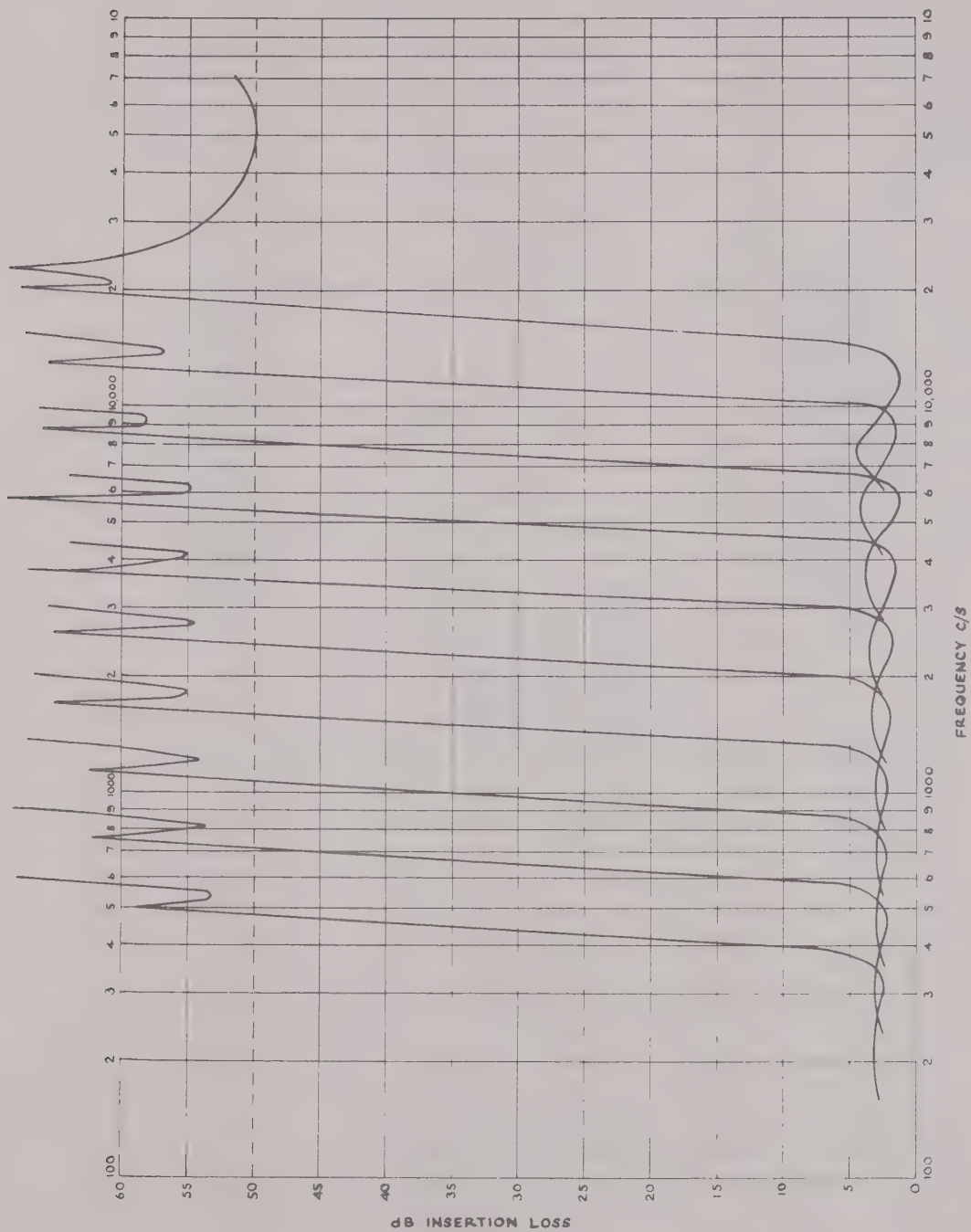
Fig.2





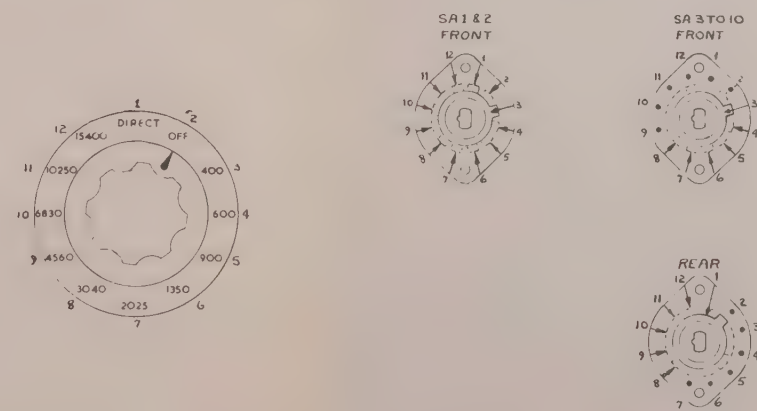
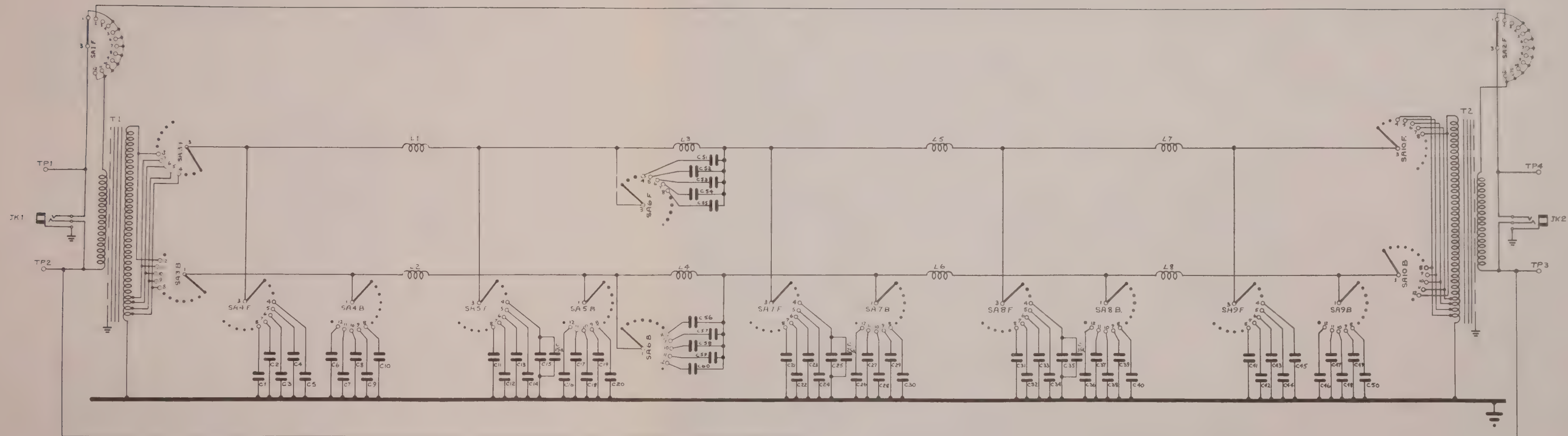
Typical Performance Curves - Highpass Figure 3





Typical Performance Curves - Lowpass Figure 4



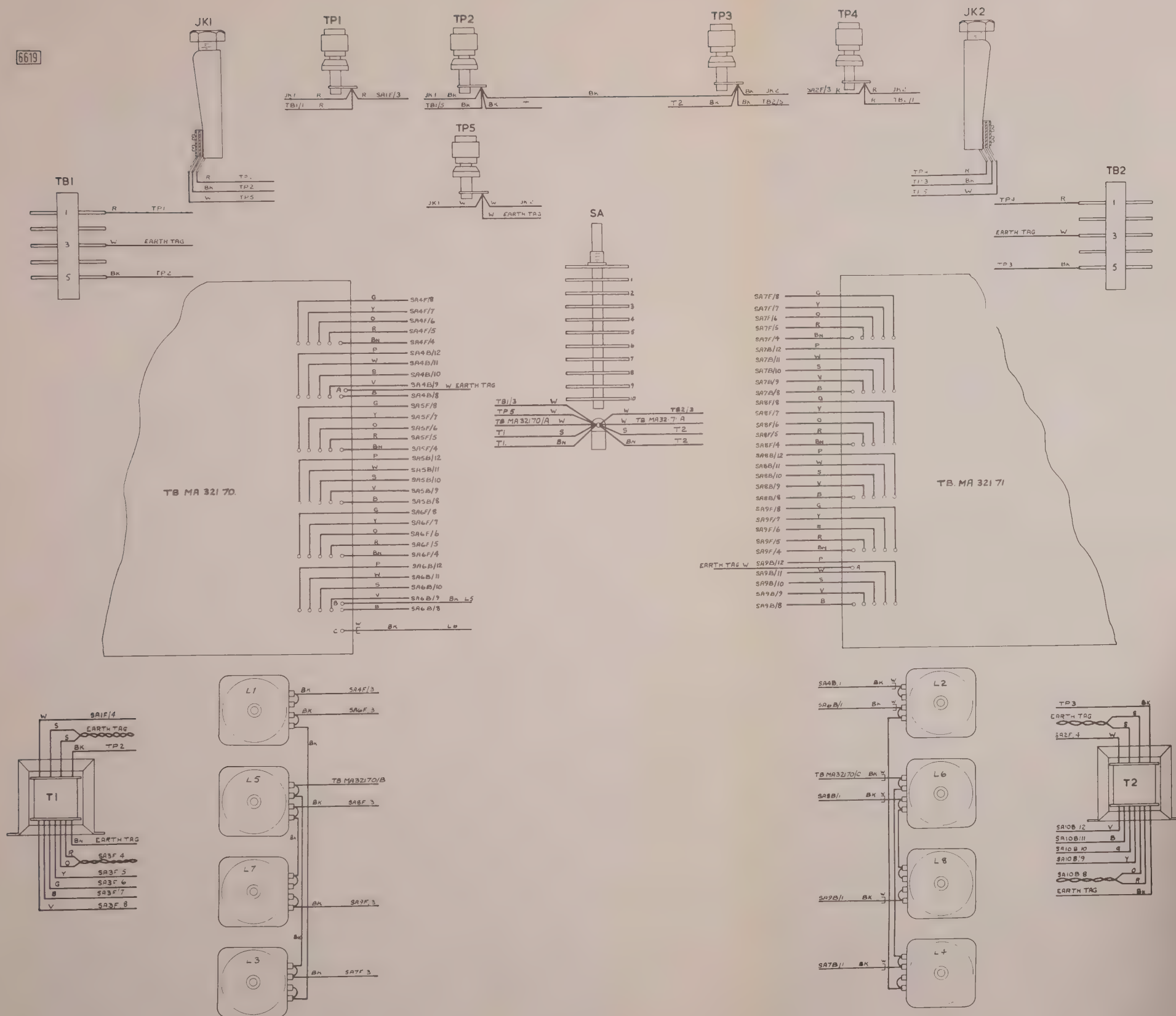


Low Pass Filter Circuit Diagram

Fig.5



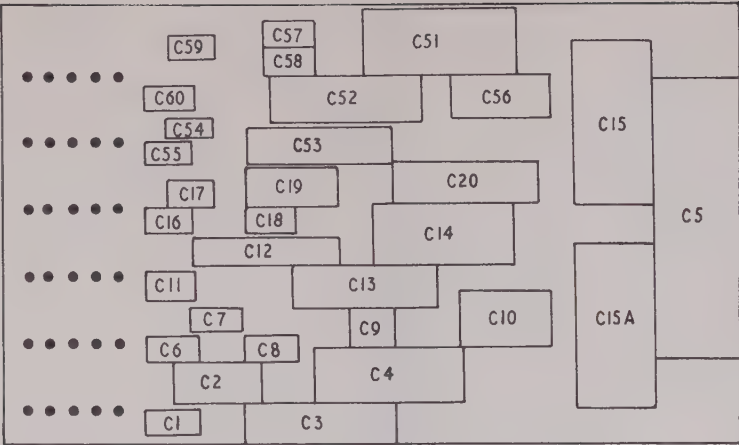
6619



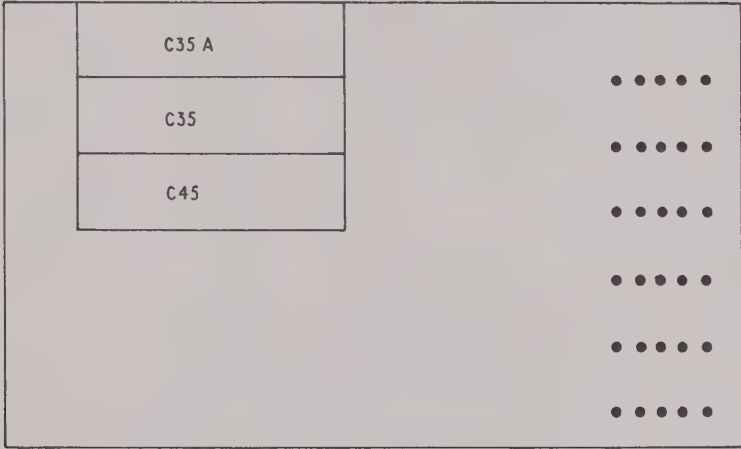
Low Pass Filter Wiring Diagram

Fig.6

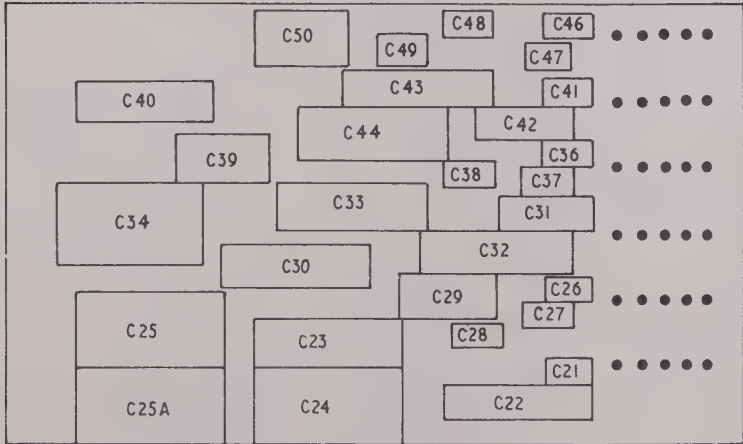




Printed Circuit Board MA 321 70 (Top View). Fig.7



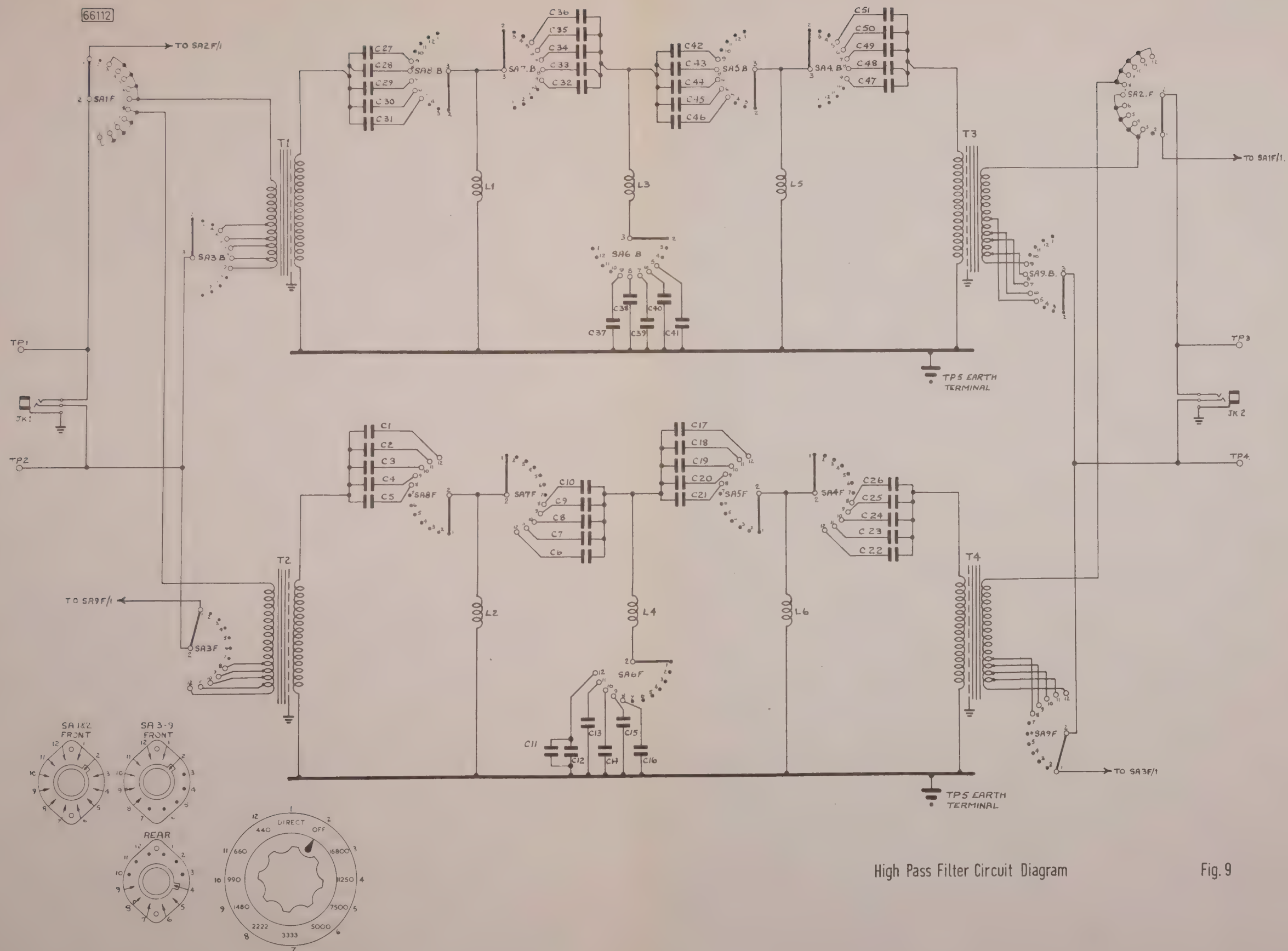
Printed Circuit Board MA 321 71 (Underside View). Fig.8(a)



Printed Circuit Board MA 321 71 (Top View). Fig.8(b)



66112

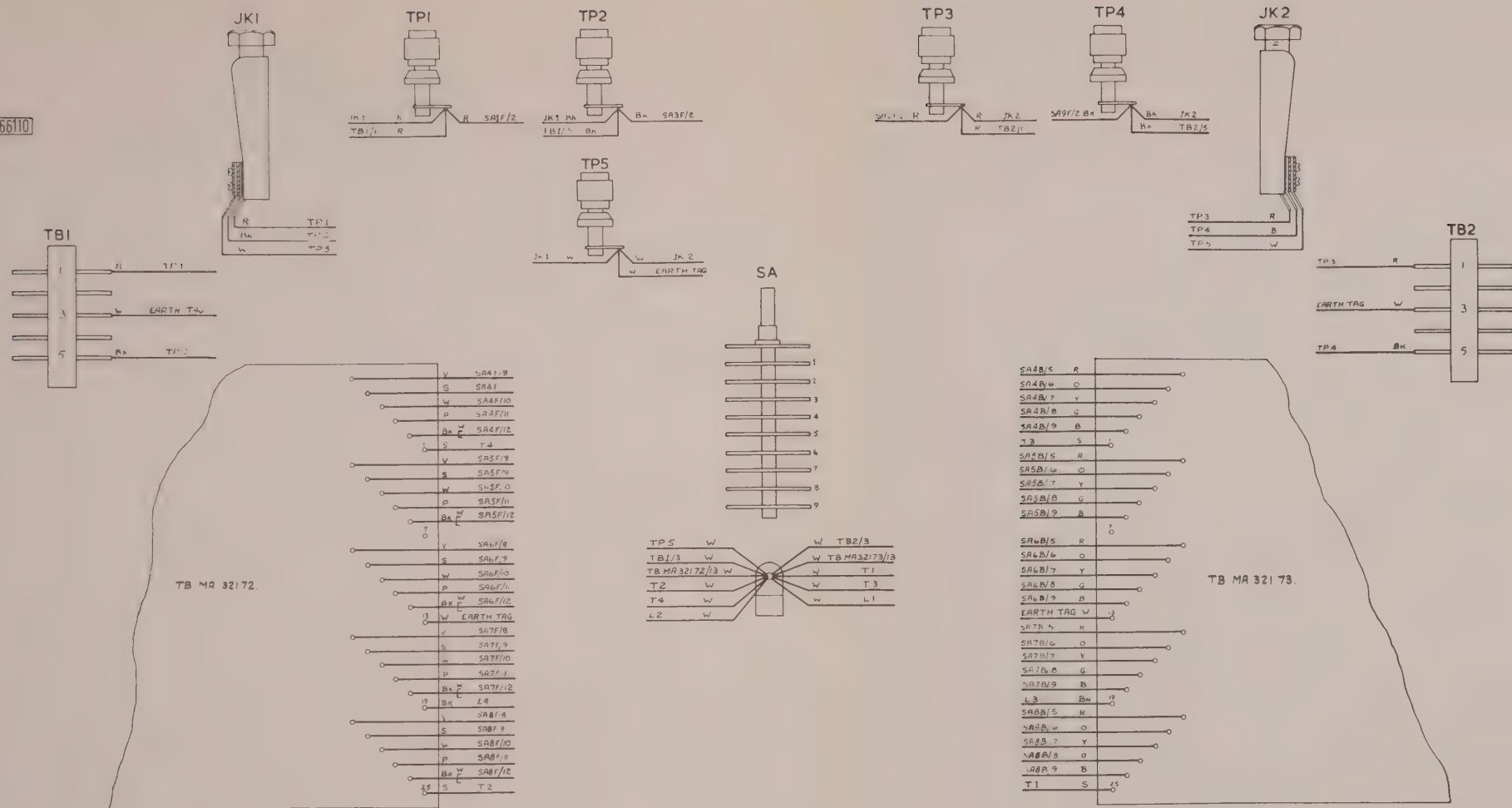


High Pass Filter Circuit Diagram

Fig. 9



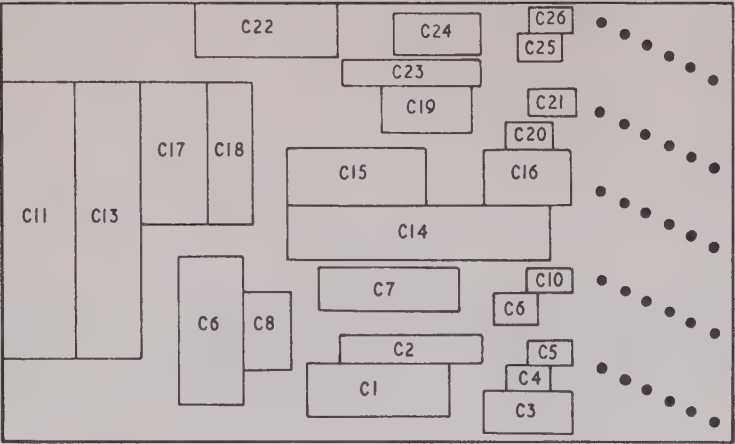
66110



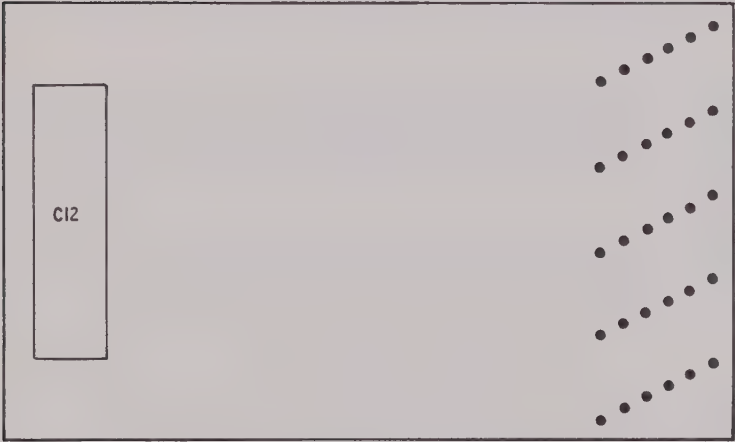
High Pass Filter Wiring Diagram

Fig.10

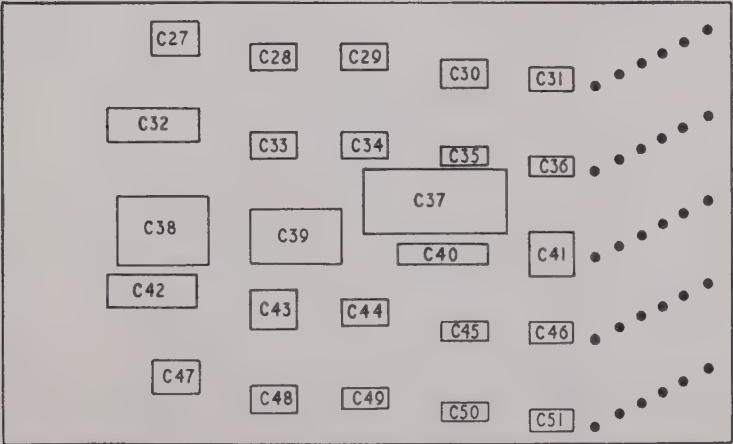




Printed Circuit Board MA 321 72 (Top View) Fig.11(a)



Printed Circuit Board MA 321 72 (Underside) Fig.11(b)



Printed Circuit Board MA 321 73 (Top View) Fig.12



## GUARANTEE

Mullard Equipment Limited guarantee each equipment or instrument manufactured and sold by them to be free from defects in material, workmanship and design. Under this guarantee they will, within one year after sale to the original purchaser, repair or replace any instrument or part thereof proved, by their inspection, to be defective.

All instruments returned under this guarantee should be sent to the manufacturer with charges prepaid. After repairs are completed the instrument will be returned with charges prepaid by the manufacturer.

This guarantee does not include valves, or other components that are already subject to a separate agreement. In the case of goods not of our manufacture, you are entitled only to such benefits as we may receive under any guarantee given to us in respect thereof.

This guarantee does not apply to any instrument which shall have been repaired or altered outside the manufacturer's organisation in any way so as, in the judgement of the manufacturer, to affect its stability or reliability, or which has been subject to misuse, negligence or accident.

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In the event of a fault developing in the apparatus herein, the defective parts will be dealt with in accordance with the conditions of the Guarantee issued with the instrument.

Any defective part, which may be located with the aid of the information contained herein, or as a result of correspondence, should be returned to our Service Department together with details of the fault.

Please note that all correspondence of a technical nature should be addressed to our Service Department at the following address:-

Mullard Equipment Limited,  
Manor Royal,  
Crawley,  
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Telephone: Crawley 28787





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